Watershed Delineation by Arc Hydro Tools

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Abstract: *Arc-Hydro is a model developed for building hydrologic information systems to synthesize geospatial and temporal water resources data that support hydrologic modeling and analysis. The model is developed as an extension or Add-on to ArcGIS software. Geo-spatial modelers working with water resource management areas use the Add-on toolbar through sequential drop-down menu tools available in the toolbar. However, if we do not follow the sequence properly, and make a mistake with one tool of the sequence, we would fail to run the entire Arc-Hydro model to obtain the intended delineated watersheds for our research. It is a big problem with novice users, who make such mistakes often. The coding for the Arc-Hydro tools refers to a designated folder for storing the output files (which are referred by the next tool in the sequence) with a pre-defined designated name. if once make a mistake in one step, next time to correct it we must be delete the result of wrong files from the folder, before to the next step. Therefore, in this study, we have developed a comprehensive geospatial model in ArcGIS Model Builder, utilizing ArcHydro tools that are developed individually and available through the ArcGIS developer's library. Finally using this tool, a user can obtain the desired result with three clicks. They have the option to set their input data, output file names, and output folders of their convenience.*

Keywords: ArcGIS, Arc-Hydro, Watershed delineation

1. Introduction

Arc Hydro is a model developed for building hydrologic information systems to synthesize geospatial and temporal water resources data that support hydrologic modelling and analysis. The model is developed as an Add-on to ArcGIS software.. The Arc Hydro tools (part of the Arc Hydro Add-on toolbar) generates several datasets that collectively describe the drainage pattern of a catchment. Most watershed managers use this facility more than other advanced hydrologic analyses for their watershed management requirements At the outset, a raster analysis is performed to generate data, steps are flow direction, flow accumulation, stream definition, stream segmentation, and finally watershed delineation.

During the watershed delination, if one does not follow the proper sequence or makes an error with one tool of the sequence, the Arc Hydro model fails to run the entire model and does not delineate watersheds. It is a big problem with novice users, who make such mistakes often. The coding for the Arc-Hydro tools refers to a designated folder for storing the output files (which are referred by the next tool in the sequence) with a pre-defined designated name. Once we make a mistake in one tool, next time to correct it we have to delete the resultant wrong files from the folder, else proceeding to the next step in the sequence would be a problem.

2. Main objective

To delineate watershed form DEM using the Arc Hydro tools.

3. Materials and Methods

3.1 Data required for the study

The major data used for the study was the 30m DEM downloaded from the open topology (https://opentopography.org).
Arc Hydro tools/ Extension, also download for all versions (https://en.geojamal.com/2015/12/downlaod-all-version-of-archydro-arcgis.html), based on what version of ArcGIS used. For this study, the Arc GIS 10.3 used so arc hydro tools 10.3 required.

3.2 Arc Hydro modeling procedure for watershed delineation

The procedure used for watershed delineation in Arc Hydro involves a sequence of steps are listed below:

- ➢ DEM download and load to ArcMap
- ➢ Filling sinks
- ➢ Flow direction and accumulation
- ➢ Stream definition and segmentation
- ➢ Catchment Gird delineation and polygon processing
- ➢ Drainage line processing and adjoint catchment processing

A. Fill Sinks

Fills sinks in a grid. If the cell is surrounded by higher elevation cells, the water is trapped in that cell, which means there is no flow of water. The Fill Sinks tool modifies the elevation value to eliminate these problems, and Sinks should be filled to ensure proper delineation of basins and streams. To avoided the water which are retain due to sink problem we must be filled the sink first.

The tool can also be used to remove maximum, which are high cells with an elevation greater than would be expected given the trend of the surrounding surface.

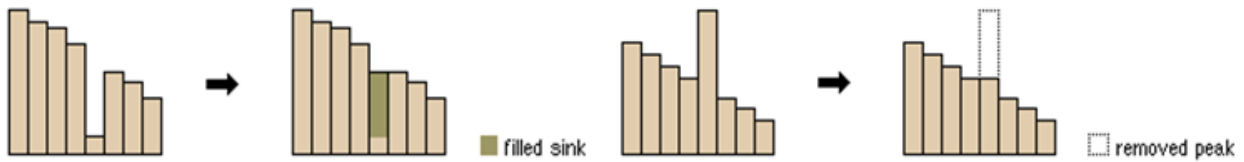**A** (filled sink) **B** (removed peak), (Source: Arc Hydro manual)

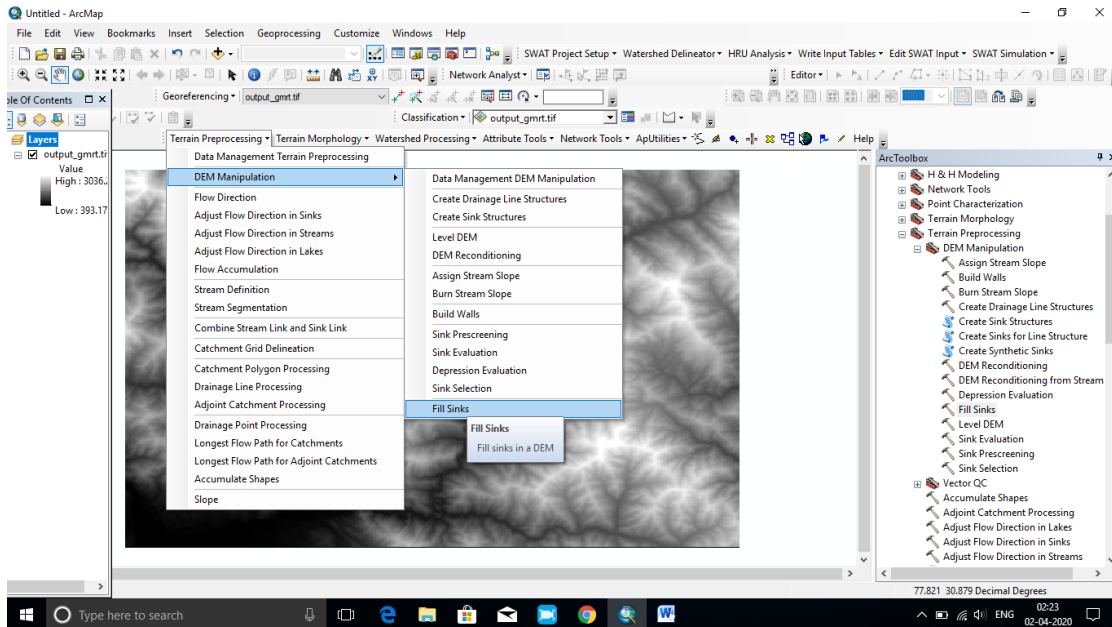**Figure 1;** Fill sink

Figure 2: Fill sinks process

B. Flow Direction

It generates the flow direction grid where each cell indicates the direction of the steepest descent from that cell. Ones the 0uter Wall Polygon is specified, the resulting Flow Direction Grid will be masked to this feature class, and this allows getting rid of the expanded extent created by the Build Walls Function.
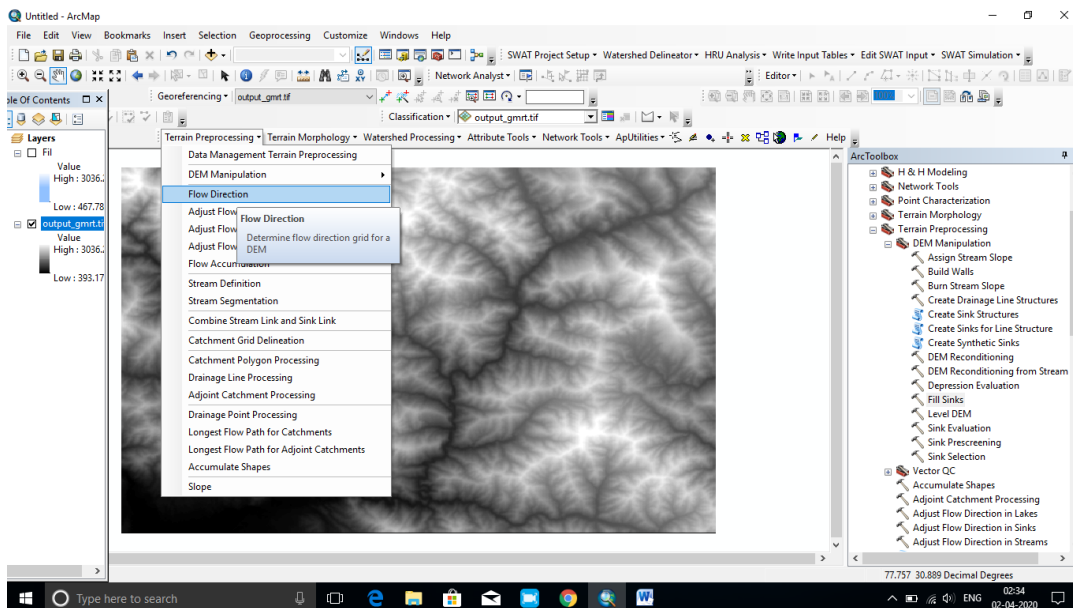

Figure 3: Flow Direction

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C. Flow Accumulation

This tool generates the Flow Accumulation grid associated with the input flow direction grid: each cell in the flow accumulation grid stores the number of cells located upstream of that cell.
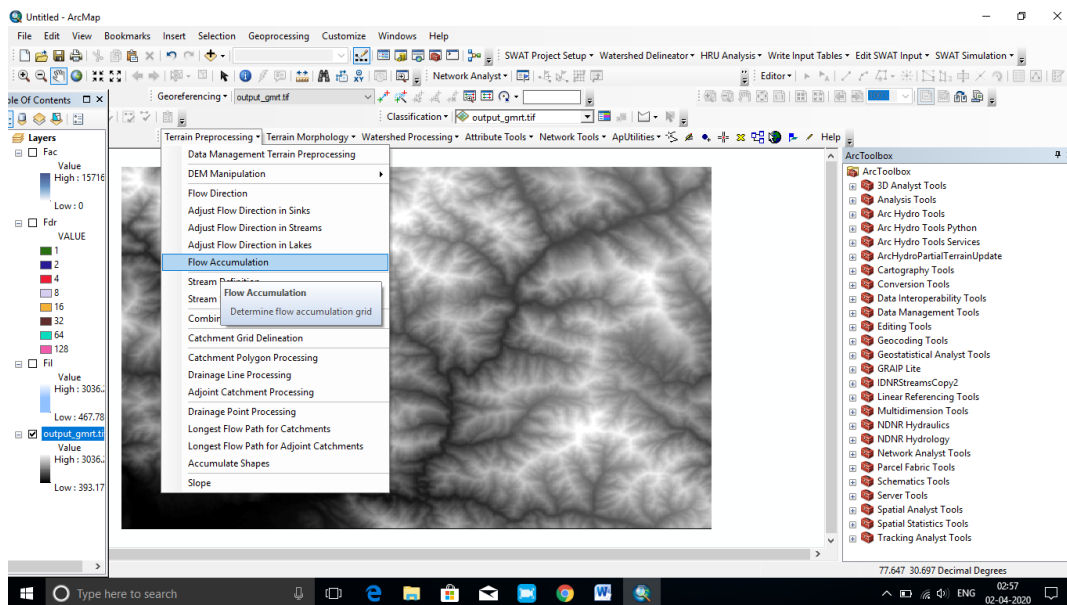

Figure 4: Flow Accumulation

D. Stream Definition

Unlike the related function in the standard Arc Hydro tools, you need to specify the threshold in several cells defining where a stream should start without any feedback from the function. The recommended value is usually around one present of the maximum flow accumulation value.
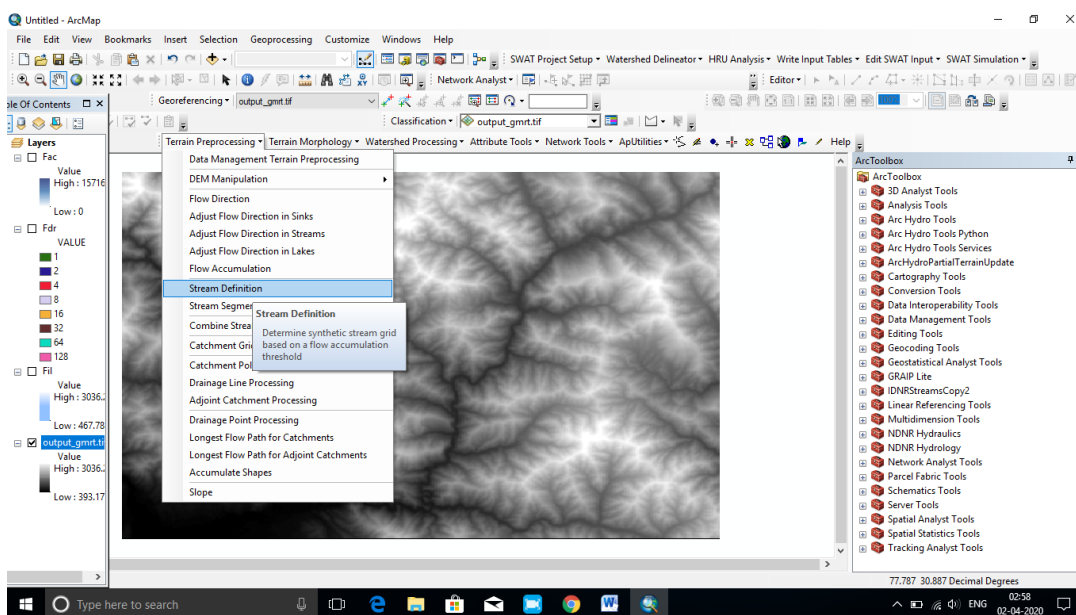

Figure 5: Stream Definition

E. Stream Segmentation

This tool generates the stream link grid for an input stream grid and flows direction grid. All cells in a given link segment have the same value that uniquely identifies the segment.
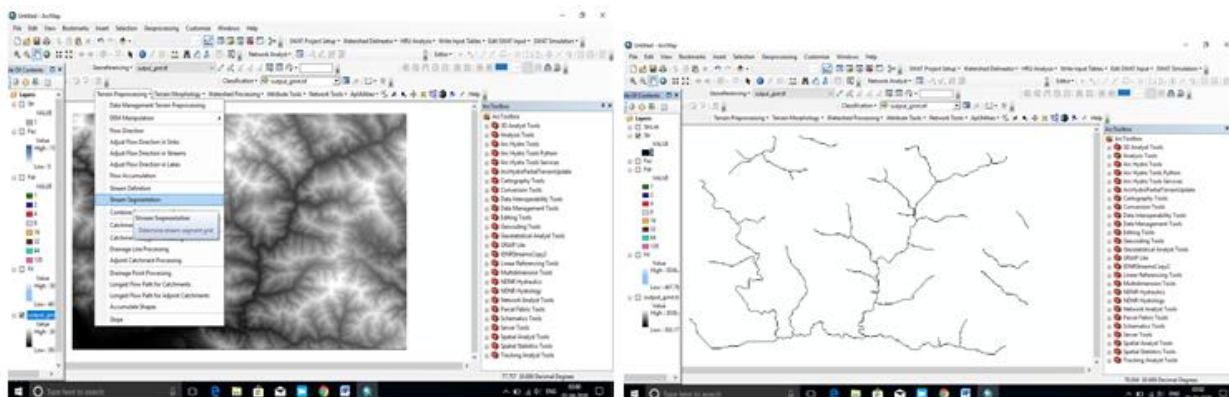
Figure 6: Stream Segmentation

F. Catchment Grid Delineation

This tool generates the catchment grid associated with an input flow direction grid and link grid.

Cell carries a value (grid code) indicating to which catchment the cell belongs, and value corresponds to the value carried by the stream segment that drains that area, defined in the input Link grid.
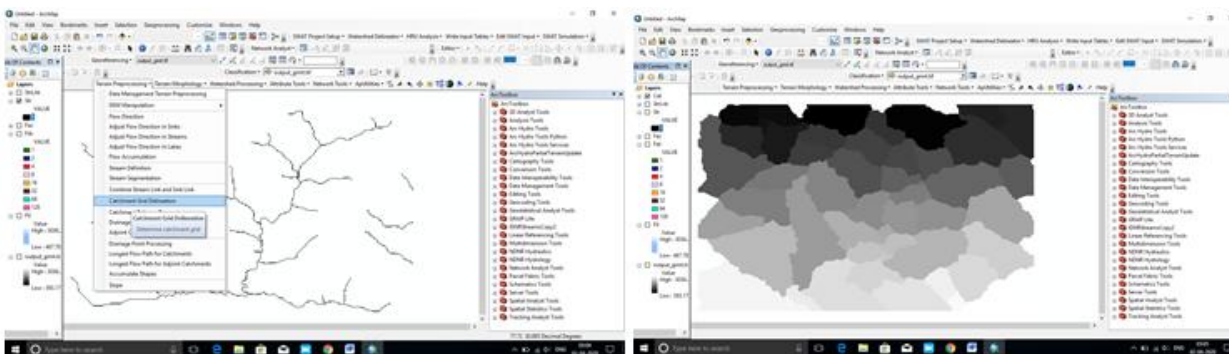

Figure 7: Catchment Grid delineation

G. Catchment Polygon Processing

This tool generates the catchment polygon feature classes corresponding to the input catchment grid and Converts an input catchment grid into a catchment polygon feature class.
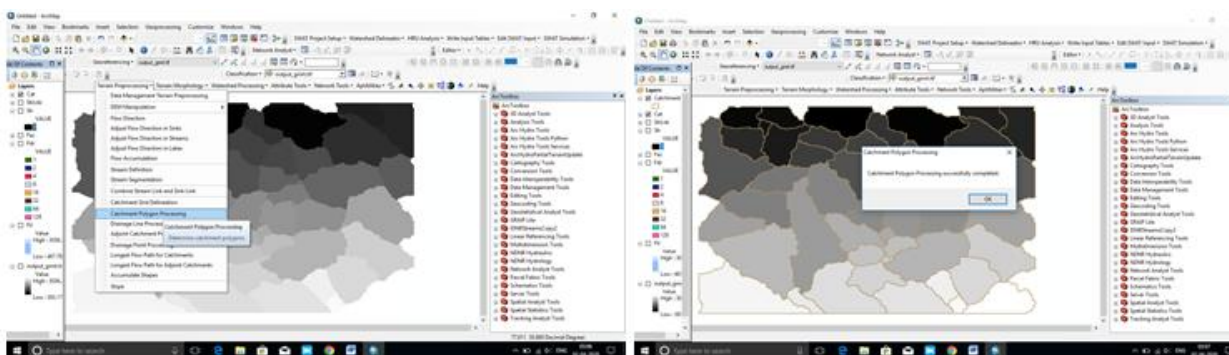

Figure 8: Catchment Polygon Processing

H. Drainage Point Processing

This tool generates the drainage point feature class associated to an input catchment feature class with flow accumulation grid, and finally drainage Point features represent the location of the cell, and the maximum flow accumulation value within each catchment.
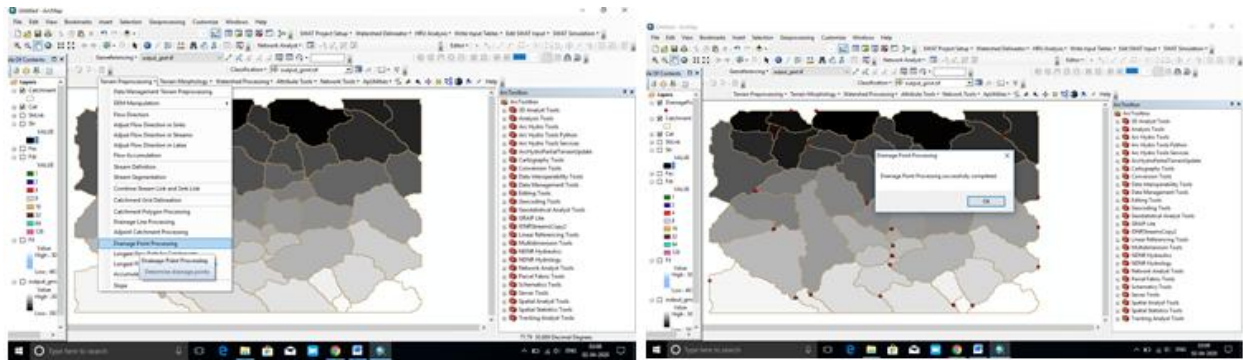
Figure 9: Drainage Point Processing

I. Adjoint Catchment Processing

This tool generates the adjoint catchment polygon feature class associated with an input catchment including drainage line feature classes.

Generate the aggregated upstream catchments from the "Catchment" feature class. For each catchment there is not ahead catchment, a polygon representing the whole upstream area draining to its inlet point is constructed and stored in a feature class that has an "Adjoint Catchment" tag, and this feature class is used to speed up the point delineation process.
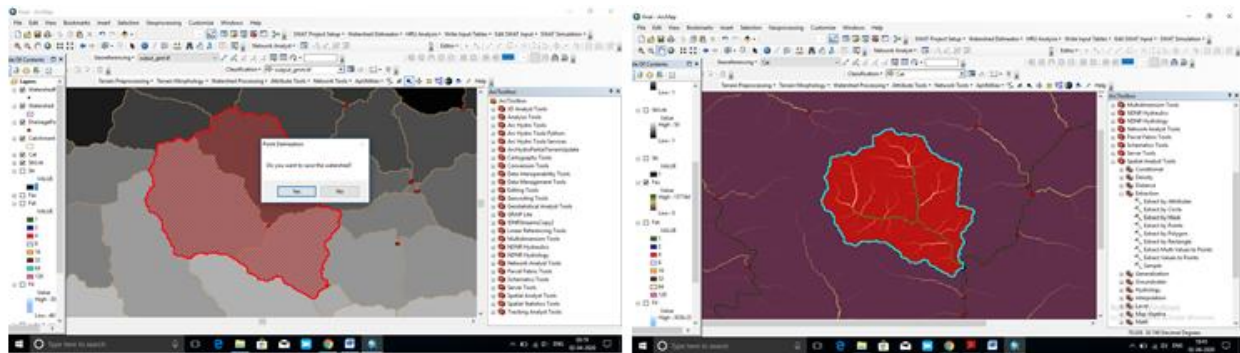

Figure 10: Adjoint Catchment Processing

J. Watershed delineation

A watershed is an area of land that feeds all the water running under it and draining off of it into a body of waters. It collect together by combines with other watersheds to form a network of rivers or streams that progressively drain into larger water area.
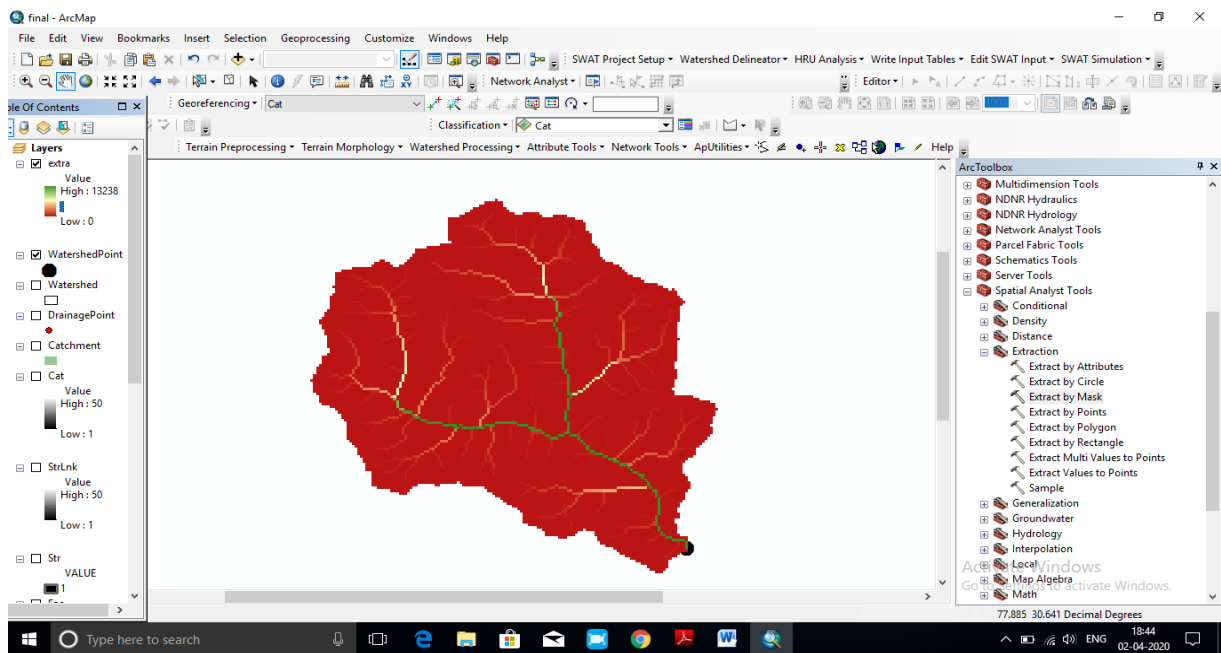

Figure 11: Watershed delineation

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4. Conclusion

Arc Hydro Tools were used to extract watershed features, with extraction in several different stages needs to select threshold. Choice of the threshold are depends on two factors: Firstly, the practical need, such as filling the sink threshold; secondly, needs multiple tests to identify the most appropriate threshold for the study. The good represent for this is, when generating streams, if the threshold is too small the river network is too dense. If the threshold is too large, the steam will be thin and the results lack practical significance.

Finally in this study results shows as the extracting of watershed features delineation automatically based on Arc Hydro tools are the most effective and feasible methods.

References

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